Section 5 ■ CONTENTS

Section 5
WATER SUPPLY AND USE

This section discusses historical flows, developable water supplies, present water uses, and interbasin water supply planning.

5.1 INTRODUCTION

The Bear River Basin is one of the few areas in the state where there appears to be an adequate developable water supply to meet existing and projected needs. The Bear River's average annual inflow to the Great Salt Lake is approximately one million acre-feet. Some of this water can be stored and developed to meet future needs.

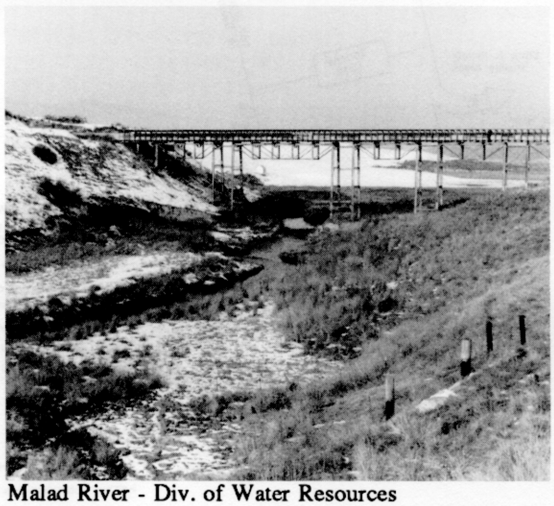
5.2 WATER SUPPLY

Before considering how much of the water supply could be developed, it is helpful to review the streamflow records. Locations, amounts, and probabilities of basin water supplies are discussed on the following pages.

5.2.1 Historical Flows

On Figure 5-1, a schematic flow chart shows the relative size of annual stream flows in the Bear River throughout its length, as well as tributary inflows, diversions, and inflows from groundwater, based on 1941-90 data. The path of Bear River mainstem flow is indicated on the chart, beginning with the headwaters at the lower right. The width of the mainstem and tributaries is roughly proportional to average annual flow in acre-feet. The flow in acre-feet is shown at gaging station locations and other points on the chart.

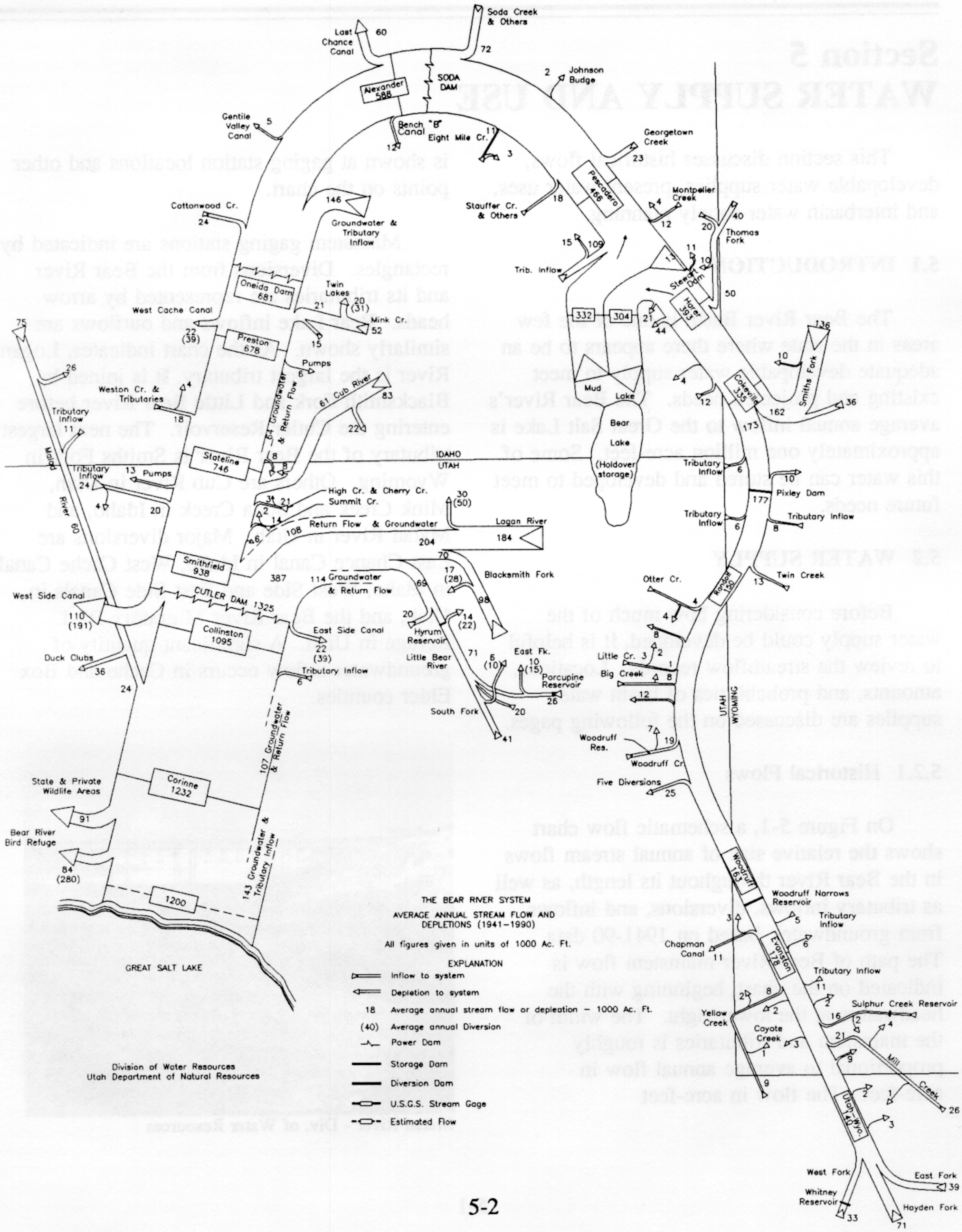
Mainstem gaging stations are indicated by rectangles. Diversions from the Bear River and its tributaries are represented by arrow heads. Bear Lake inflows and outflows are similarly shown. As the chart indicates, Logan River is the largest tributary. It is joined by Blacksmith Fork and Little Bear River before entering the Cutler Reservoir. The next largest tributary of the Bear River is Smiths Fork in Wyoming. Others are Cub River in Utah, Mink Creek and Soda Creek in Idaho, and Malad River in Utah. Major diversions are Last Chance Canal in Idaho, West Cache Canal in Idaho, West Side and East Side Canals in Utah, and the Bear River Migratory Bird Refuge in Utah. A significant quantity of groundwater inflow occurs in Cache and Box Elder counties.



Malad River - Div. of Water Resources

FIGURE 5-1

BEAR RIVER FLOW CHART

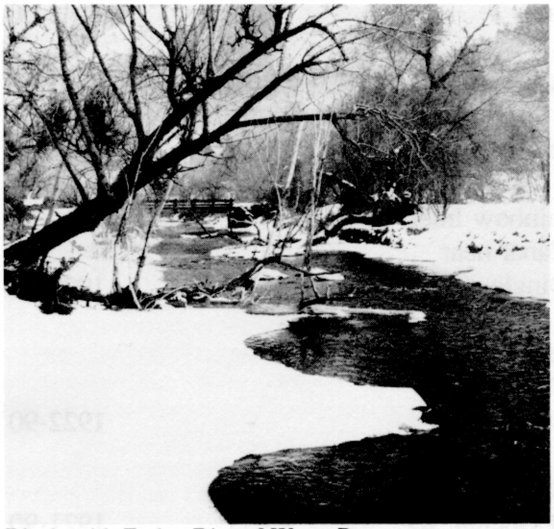


The stations above Bear Lake and on most of the tributary streams throughout the entire basin are operated by the U.S. Geological Survey (USGS). In cooperation with USGS, the Utah Power & Light Company (UP&L) operates and maintains most of the mainstem stations downstream from Bear Lake. Below the Corinne gage, a portion of the water is diverted into the Bear River Migratory Bird Refuge (See Figure 5-1).

A summary of key streamflow records is shown in Table 5-1. The main object of this table is to show flow characteristics along the Bear River, especially average annual runoff volumes. The Bear Lake outlet and inlet canals are included in order to show the effect of Bear Lake operations on downstream river flows. In all but extremely high runoff years, the entire flow of Bear River is diverted into Bear Lake. With the exceptions of these two canals, all of the streamflow records in Table 5-1 are from mainstem gaging stations. They are listed in downstream order, beginning with the Bear River crossing of the Utah-Wyoming state line, and ending with the last gaging station on the river (near Corinne) before it enters the Great Salt Lake. The Harer, Idaho, Station was just above the canal diversion into Bear Lake. The station was operated by UP&L until removed from service in 1986. The Collinston, Utah, Station is immediately below the Cutler Dam and powerplant. This record, extending back to 1889, is the longest in the Bear River Basin, and one of the longest in Utah.

The 50-year interval of 1941-90 is a representative base period for streamflow averages and other hydrologic computations. Weather cycles with both extremely high and extremely low years are included in this period (See Figure 5-2).

Another important flow characteristic, in addition to average annual volume, is low flow. The frequency of occurrence of low flows, the degree to which they approach zero, the duration, and the season(s) when they occur, are all significant environmentally as well as for water supply and recreation. In Table 5-2, low-flow records are shown for five mainstem locations and six tributary streams. These 11 records were selected as being somewhat representative of the entire basin. Only four of the gaging stations are entirely free of the effects of upstream storage or diversions (Big Creek, High Creek, Logan River, and Blacksmith Fork).



Blacksmith Fork - Div. of Water Resources

Recorded instantaneous minimums alone do not convey the true picture of low-flow conditions. The lowest average day is probably more meaningful, or even the lowest average month. To give a better perspective, both of these properties are shown in Table 5-2, along with the long-term annual average. For example, the difference between lowest day, lowest month, and average year-round flow is not very great for Logan River and Blacksmith Fork, and also for Bear River at the Utah-Wyoming state line. But for the Bear River above and below Woodruff Narrows Reservoir and at the Idaho-Utah State line, and Woodruff Creek below the reservoir, the difference is much greater. For comparison, the extremely low flows for 1977 and average year-round flows are shown in Table 5-2.

TABLE 5-1
STREAM GAGING RECORDS[6]

Gaging Station on Bear River[a]	Drainage Area (square miles)	Period of Record	Instantaneous Extremes Minimum (cfs)	Instantaneous Extremes Maximum (cfs)	Average Annual Runoff 1941-90 (1,000 acre-feet)
Near UT-WY State Line	172	1942-90	12	2,980	139.9[b]
Near Randolph, UT	1,616	1943-90	2	3,630	160.1
At Harer, ID	2,839	1913-86	26	5,140	393.1
Rainbow Inlet Canal near Dingle, ID	N.A.	1922-90	0	4,420	304.0
Bear Lake Outlet Canal near Paris, ID	-	1922-90	1	2,010	332.0
Below tailrace, at Oneida, ID	4,455	1921-90	3	5,480	681.3
At ID-UT State Line	4,881	1970-90	48	4,870	746.4[b]
Near Collinston, UT	6,267	1889-1990	6[c]	12,700	1,094.7
Near Corinne, UT	7,029	1949-57 1963-90	72	14,770	1,232.0[b]

[a]Except the Bear Lake outlet and inlet canal gaging stations, which are not on Bear River.
[b]Part of record estimated by correlation with another station.
[c]Minimum day. See Table 5-2.

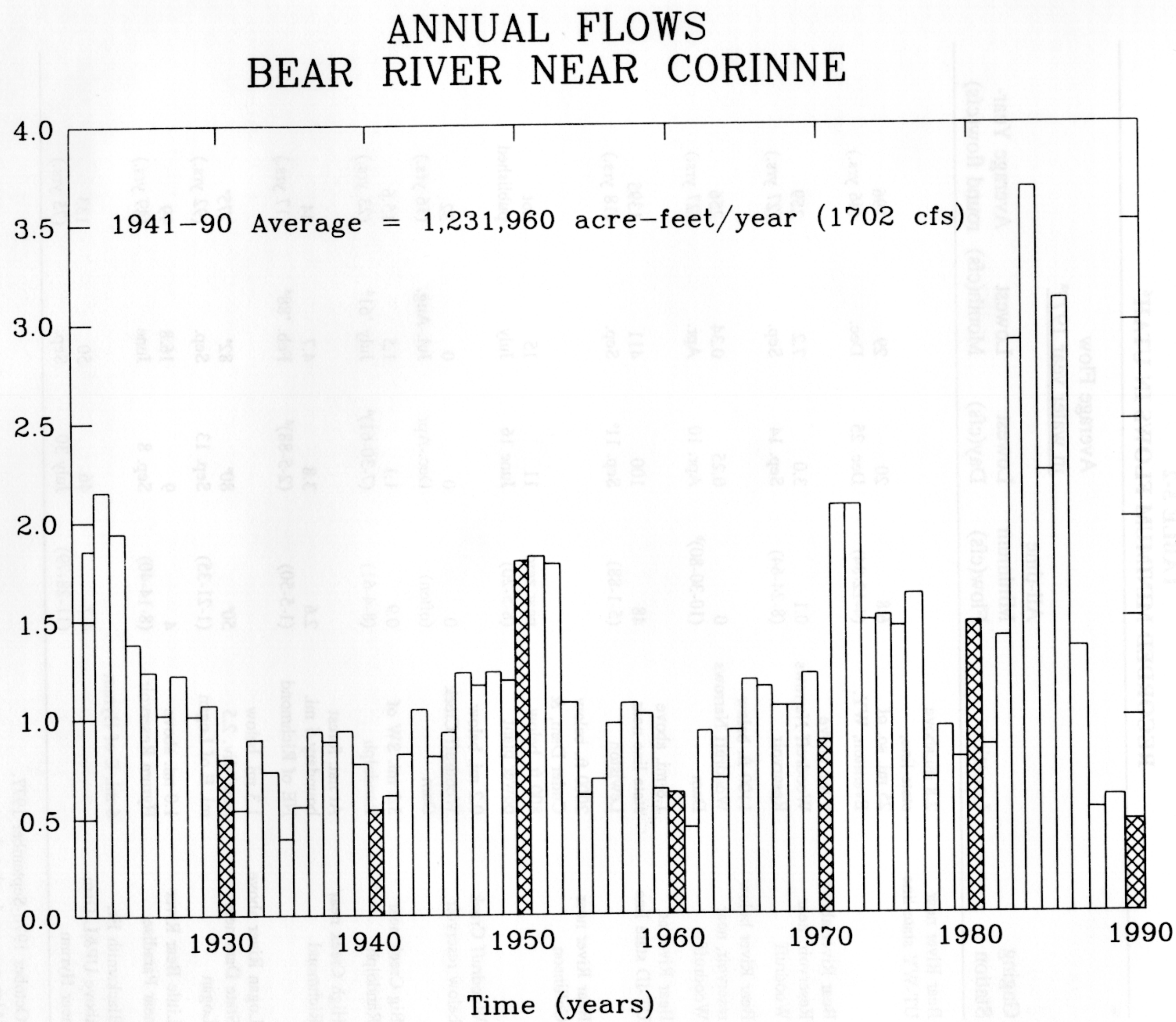
Figure 5-2 is a bar chart of annual runoff at the Corinne gage for a 70-year period extending back to 1921. The greatest runoff year was 1984, and the smallest was 1934.

TABLE 5-2
RECORDED MINIMUM FLOWS IN UTAH[6]

Gaging Station	Location	All-time Minimum Flow(cfs)	Average Flow in water year 1977[a] Lowest Day(cfs)	Lowest Month(cfs)	Average Year-round flow(cfs)
Bear River near UT-WY state line	2.8 mi.above state line, 25 mi. so. of Evanston, WY.	6.8 (4-12-84)	20 Dec. 25	29 Dec.	196 (46 yrs.)
Bear River above Reservoir, near Woodruff	5 mi. above Woodruff Narrows Reservoir	0.1 (8-24-64)	3.0 Sep. 14	7.2 Sep.	259 (27 yrs.)
Bear River below reservoir, near Woodruff	1100 ft. below Woodruff Narrows Dam	0 (10-30-80)[b]	0.25 Apr. 10	0.34 Apr.	256 (27 yrs.)
Bear River at UT-ID state line	1.8 mi. above state line near Lewiston	48 (5-1-88)	100 Sep. 11[c]	411 Sep.	1395 (18 yrs.)
Bear River near Collinson	2000 ft. below Cutler Dam, & 800 ft. below power plant	near zero (8-5-20)	11 June 16	15 July	not published
Woodruff Creek below reservoir	0.2 mi. below Woodruff Creek Dam	0 (often)	0 Dec.-Apr.	0 Jul.-Aug.	32 (16 yrs.)
Big Creek near Randolph	5.2 mi. SW of Randolph	0.9 (8-4-61)	1.1 (7-30-61)[d]	1.5 July '61[d]	15.6 (23 yrs.)
High Creek near Richmond	At nat. forest boundary 5 mi. NE of Richmond	2.6 (1-5-50)	3.8 (2-5-88)[d]	4.7 Feb. '88[d]	34 (17 yrs.)
Logan River above State Dam near Logan	1.3 mi. below canal div. 2.5 mi. E of Logan	50[e] (1-21-35)	80[e] Sep. 13	82[e] Sep.	275[e] (92 yrs.)
Little Bear River near Paradise	1.0 mi. above Hyrum Reservoir	4 (8-14-40)	9 Sep. 8	16.8 June	99 (49 yrs.)
Blacksmith Fk. above UP&L Dam near Hyrum	6 mi. E of Hyrum	4.7 (11-28-79)	46 July 30	50 Sep.	133 (75 yrs.)

[a]October 1976-September 1977.
[b]Also zero on 6 other days.
[c]Also 100 cfs on several other days in 1977.
[d]No record in 1977.
[e]Combined flow, including canal and powerplant diversions. Equivalent to natural flow above diversions.

FIGURE 5-2


ANNUAL FLOWS
BEAR RIVER NEAR CORINNE
1941–90 Average = 1,231,960 acre–feet/year (1702 cfs)
Flow (million acre–feet)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1930
1940
1950
1960
1970
1980
1990
Time (years)

5.2.2 Supply Available for Development

The amount of water that can be developed is limited by the following:

(1) Amended Bear River Compact
(2) Existing Utah water rights
(3) Wide variation in annual runoff
(4) Scarcity of feasible and environmentally acceptable storage sites

Because of these limitations, it is difficult to quantify the exact amount of new water supply that will be developed in the future.

(1) Amended Bear River Compact - In Section 7.2, the Amended Bear River Compact of 1980 is discussed in detail, with an explanation of the permanent allocations agreed on by Wyoming, Utah, and Idaho. Above Stewart Diversion Dam, there are allocations to all three states. But below Stewart Dam (the "Lower Division"), only Idaho and Utah are involved.

In the upper basin (above Stewart Diversion Dam), some further development became allowable under the amended compact. The additional development was defined in terms of new annual storage and annual depletion. For Utah, these allowable amounts were 35,000 acre-feet of storage and 13,000 acre-feet of depletion. The remaining portions of these allowances at the present time are 17,000 acre-feet of storage and 6,314 acre-feet of depletion. In addition, water can be stored upstream when Bear Lake is full and spilling, but this water is not reliable since it may be available only once every 10 to 20 years. By compact definition, the Bear Lake Valley in Rich County is in the "Lower Diversion."

Below Stewart Dam, where the margin of potential development is large, the allocation formula provides for equitable development in both Idaho and Utah. Also, the compact makes provision that the water supply would be shared in accordance with a set of priority rights (See Table 7-1 in Section 7). For example, with development in both states reaching a total annual depletion of 550,000 acre-feet, Utah's share of depletions under the Compact would be 350,000 acre-feet.

2) Existing Utah water rights - Any future development, whether private, state, or federal, must recognize and make careful provision for existing water rights. One of the largest and most significant water rights in relation to potential development of the lower Bear River is that of the Bear River Migratory Bird Refuge. With adequate new reservoir storage, the average historical use of about 280,000 acre-feet/year could be increased to meet late summer needs. This is discussed further in Section 14.

The most important water rights affecting present operations are those held by UP&L. These rights affect not only the operation of Bear Lake, but also the entire length of Bear River from Bear Lake down to Cutler Dam.

(3) Wide variation in runoff - Because of the wide variations in annual flow volume, dependable water supplies are no greater than the lowest recorded year, plus some level of acceptable shortage, plus carryover storage (from one year to another).

Figure 5-2 shows annual flows of the Bear River near Corinne. In the 1941-90 base period, the maximum was 3,666,000 acre-feet in 1984, and the minimum was 442,700 acre-feet in 1961. Other comparisons are shown in Table 5-3 on the following page.

A statistical probability study based on a 1941-90 period of analysis for the same gaging station indicates a 90-percent probability that the annual flow volume in any random year will be 601,400 acre-feet or greater. Also, there is a 75-percent probability that it will be 793,900 acre-feet or greater (under present conditions of development).

TABLE 5-3
RUNOFF COMPARISONS FOR BEAR RIVER (SEE FIGURE 5-2)

Annual runoff[a] (acre-feet)	Number of years this runoff was exceeded[b]
400,000	50
500,000	48
600,000	46
700,000	39
800,000	37
900,000	34
1,000,000	29
1,250,000	16
1,500,000	11
(Average) 1,231,960	17
(Average) 1,065,000	25

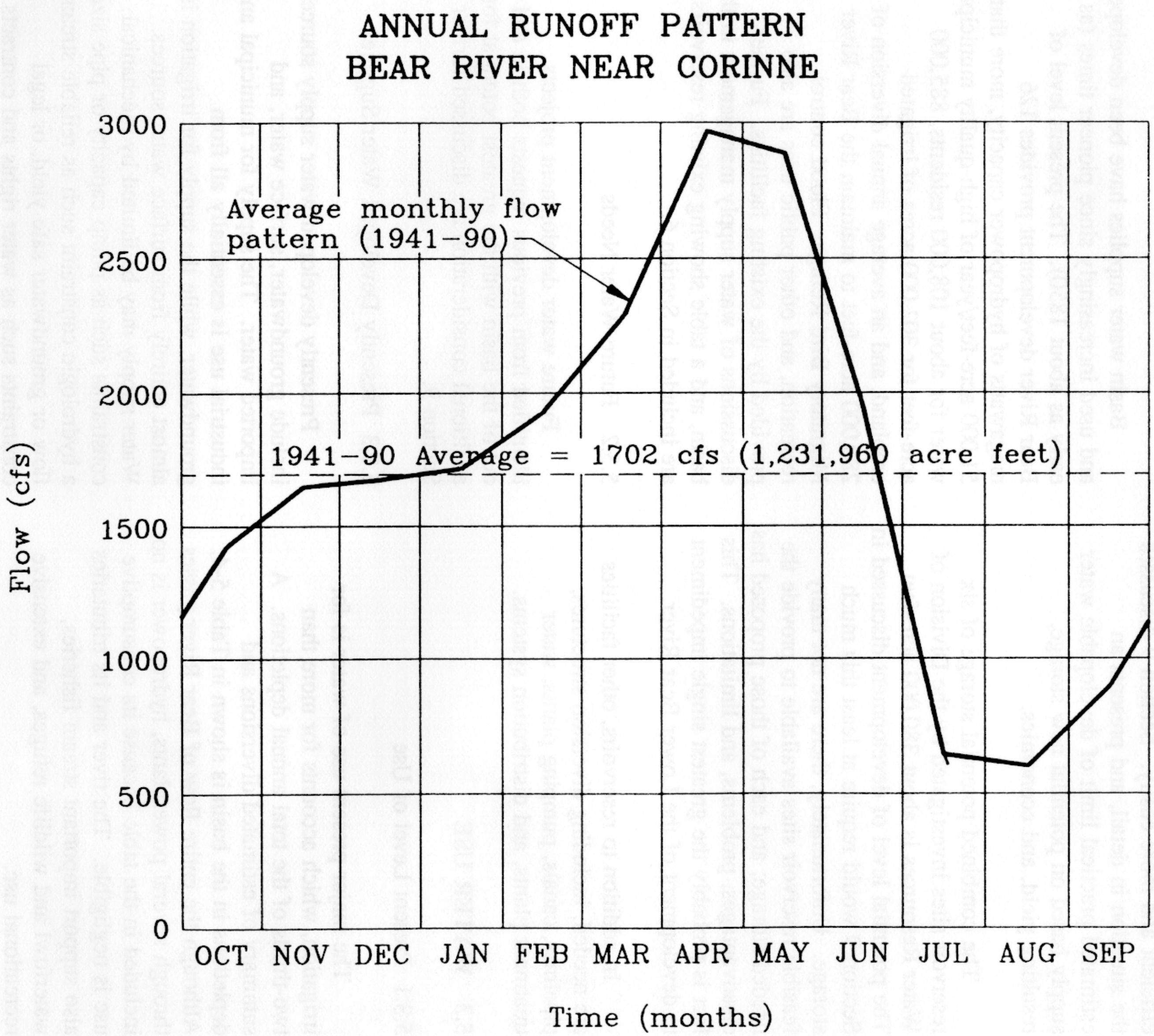
[a]Bear River near Corinne
[b]Based on 50 years of record (1941-90)

When Idaho develops its share of Bear River water in accordance with the amended compact, the remaining downstream flow at Corinne available for development in Utah will be less by the amount of Idaho's depletion. For example, if Idaho's development were to result in a depletion of 125,000 acre-feet/year, the remaining water available for development in Utah would be about 476,000 acre-feet (for a year of 90-percent probability). After subtracting 280,000 acre-feet for the approximate amount presently being used at the Bear River Migratory Bird Refuge leaves about 196,000 acre-feet/year available for development in Utah (in terms of depletion).

The runoff pattern at Corinne during a typical year (using average monthly values) is shown on Figure 5-3. About 60 percent of the annual flow occurs during the snowmelt season of April, May, and June, because the flow originates primarily from snowfall in the mountains. But in the heavy demand period of July, August, and September, streamflows typically decrease to their lowest levels of the year. This late-summer pattern illustrates why new reservoir storage will be needed to develop a significant new water supply.

<u>(4) Storage and other facilities needed</u> - Of the four limiting factors named earlier, the limitation imposed by reservoir storage requirements is probably the most severe. First, the amount of storage needed for the scale of development referred to above (196,000 acre-feet) is large. A computer model study[2] compared the potential storage available at presently known reservoir sites and the storage needed to supply projected needs. The study indicates, for example, that development of a new water supply in Utah with diversions of 250,000 acre-feet/year (and

FIGURE 5-3



ANNUAL RUNOFF PATTERN
BEAR RIVER NEAR CORINNE
Flow (cfs)
3000
2500
2000
1500
1000
500
0
Average monthly flow pattern (1941–90)
1941–90 Average = 1702 cfs (1,231,960 acre feet)
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
Time (months)

depletions of about 100,000 acre-feet) would require approximately 400,000 acre-feet of active storage capacity. Further increments of development beyond this level would require proportionately larger increments of storage, each of which would be hydrologically less-efficient and more costly. Section 9 discusses the situation in detail, and presents an estimated practical limit of developable water supply based on potential new storage, resulting yield, and economics.

The combined potential storage of six reservoir sites investigated by the Division of Water Resources is about 380,000 acre-feet. The potential level of development discussed in Section 9 would require at least this much storage. Unfortunately, there are not many feasible reservoir sites available to provide the needed storage; and each of those proposed has disadvantages, problems, and limitations. This fact is probably the greatest single impediment to development of the Lower Bear River.

In addition to reservoirs, other facilities are needed, including diversion structures, pipelines, canals, pumping plants, water treatment plants, and distribution systems.

5.3 WATER USE

5.3.1 Present Level of Use

The major present use of water is for irrigation, which accounts for more than two-thirds of the total annual depletions. A summary of estimated diversions and depletions in the basin is shown in Table 5-4. Although the entire flow of Bear River passes through several powerplants, hydropower is not included in the table because its consumptive use is negligible. The river and its tributaries also support important stream fisheries, waterfowl and wildlife refuges, and extensive recreational use.

Definitions of the use categories are listed in Section 5.5. Understandable difficulties in defining and estimating uses by these or any other set of categories result from confusing terminology and complex inter-relationships between uses, supply sources, and ownership of water systems. Detailed discussions of specific uses are included in other sections.

Basin water supplies have been developed and used increasingly since pioneer times (as early as about 1850). The present level of Bear River development provides 126 megawatts of hydropower capacity, more than 51,000 acre-feet/year of high-quality municipal water for about 108,000 residents, 885,000 acre-feet for 302,000 acres of irrigated cropland, and an average annual diversion of 280,000 acre-feet to maintain the Bear River Migratory Bird Refuge. Flood control, recreation, and other public uses are also provided by the existing facilities. Further discussions of water supply management in the basin, and a table showing existing reservoirs, are included in Section 6.

5.3.2 Future Water Needs

Future water development projects identified from previous requests both in and out of the basin with the greatest potential for additional consideration are discussed further in Section 9.

5.3.3 Presently Developed Water Supplies

Presently developed water supply sources include groundwater, surface water, and imported water. The supply for municipal and industrial use is essentially all from groundwater, while the supply for irrigation is almost entirely from surface water sources. Water supply may be limited by mechanical constraints such as pump capacity or pipe size, a hydrologic constraint such as reliable stream flow or groundwater safe yield, or legal constraints such as water rights and contracts. Presently developed water supplies for the basin are summarized in Table 5-5.

TABLE 5-4
ESTIMATED PRESENT WATER USE (acre-feet/year)

County	Irrigation	Municipal[a]	Industrial	Reservoir Evaporation	At Bird Refuge[b]
			Diversions[c]		
Cache	377,100	31,930	9,270	-	
Box Elder	343,700	15,900	1,020	-	280,000
Rich	153,300	3,340	20	-	
Summit	11,500	0[d]	0	-	
Total	885,600	51,170	10,310	___	280,000
			Depletions[e]		
Cache	229,800	10,630[f]	2,320[f]	15,400	
Box Elder	192,800	5,290[f]	250[f]	1,500	84,000
Rich	106,600	1,110[f]	10	63,700[g]	
Summit	6,400	0	0		
Total	535,600	17,030	2,580	80,600	84,000

[a]Consists of residential and commercial (no industrial).
[b]The Bear River Migratory Bird Refuge.
[c]"Diversions" means the volume of water diverted from streams (or pumped from groundwater) for the uses indicated.
[d]At campgrounds only.
[e]"Depletions" for irrigation means the water consumed by crops, including that which is supplied by rainfall. During the growing season, as much as one-fourth of the total consumptive use may be supplied by average rainfall. For the other four categories, depletions are estimated as consumed portion of diversions, excluding any rainfall.
[f]Based on an approximate portion of diversions: 1/3 for municipal and 1/4 for industrial (See Ref. No. 5).
[g]Including Bear Lake (portion within Utah).

5.4 INTERBASIN WATER SUPPLY PLANNING

Neither imports nor exports in the Bear River Basin are significantly large. At present there is only one of each.

The Ogden-Brigham Canal imports water diverted from the Ogden River to irrigation companies and communities as far north as Brigham City. The average annual amount imported in recent years (1985-89) is 11,600 acre-feet. Return flows and streamflow from this area go directly into the Great Salt Lake.

TABLE 5-5

PRESENTLY DEVELOPED WATER SUPPLIES[7]

SOURCE	DESCRIPTION	DIVERSIONS (Acre-feet/Year) Box Elder	Cache	Rich	Basin Total
Groundwater	Public Supply Well and Springs	18,500	43,100	3,400	65,000
	Private Domestic and Stock Wells	2,900	1,900	100	4,900
	Self-Supplied Industrial Wells	900	7,400	0	8,300
	Irrigation Wells	6,000	13,300	3,000	22,300
Subtotal		28,300	65,700	6,500	100,500
Surface Water	Irrigation Supply	304,000	352,000	142,400	798,400
	Public Supply for Residential Use	0	500	0	500
	Public Supply for Golf Course	400	0	0	400
	Supply to Wet/Open Areas	418,000	32,700	7,300	458,000
	Reservoir Evaporation Losses	1,500	15,400	[b]63,700	80,600
	Supply to Sub-irrigated Pasture/Grass Hay	22,100	11,800	7,900	41,800
Subtotal		746,000	412,400	221,300	1,379,700
Imported Water		[a]11,600	0	0	11,600
TOTAL		785,900	478,100	227,800	1,491,800

[a]Irrigation supply from Weber County
[b]Includes 62,200 for Utah portion of Bear Lake

Inflows to Willard Reservoir, on the extreme southern boundary of the basin, do not constitute an import because the water is pumped back to the south for uses in the Weber River drainage basin.

The only export from Bear River Basin occurs in the area of Alexander, Idaho, where the Bear River flows within a few miles of the hydrologic boundary. Because the basin divide is very low and flat, two canals in the area are able to carry diverted flows from the Bear River to irrigated lands west of the divide. Also, irrigation runoff near the surface water divide may feed groundwater aquifers which flow to the Portneuf River outside the basin. The maximum annual export possible with existing canal capacities is 60,000 acre-feet/year, but the actual amount is much less.

The Idaho Department of Water Resources has estimated approximately 7,600 acres were irrigated outside the basin with Bear River water in 1976. If an estimated 3.0 acre-feet/acre were diverted, annual export would be about 23,000 acre-feet.

Plans for diverting water out of the basin for various purposes have been proposed in the past. With the exception of the canals near Alexander, no plans have been implemented. The most significant and likely future export will be to meet Wasatch Front M&I needs (See Section 9).

5.5 DEFINITIONS AND CATEGORIES OF WATER USE

Irrigation - Water used for irrigation of cropland as identified in the Bear River Land Use Inventory (See Table 10-2). Residential lawn and garden uses are not included.

Municipal - Consists of the sum of "residential" and "commercial" uses, which are not usually identified separately in available records of water use. It is recognized that "municipal" is really a term for supply, but it is used for convenience.

Residential - Water used for residential household purposes and residential lawn and garden watering. Municipal irrigation of parks and golf courses is included here.

Commercial - Water used by hotels, motels, restaurants, office buildings, retail sales stores, educational institutions, churches, hospitals, and government and military facilities.

Industrial - Water used to manufacture products such as steel, chemical, and paper products. It includes petroleum refining for processing, washing, and cooling operations. In the Bear River Basin, meat packing, dairies, cheese factories, egg plants, and other food processing enterprises are included. Gravel washing and ready-mix concrete operations are also included. Estimated use for all of the above is included, whether the water is self-supplied or from a public system.

Public Water Supply - Water supplied to either private or publicly owned community systems which serve at least 15 service connections or 25 individuals at least 60 days per year. Water from public supplies is used for residential, commercial, and industrial purposes, including irrigation of publicly owned areas.

Secondary Systems - Pressurized lawn and garden irrigation systems using untreated water for irrigation of lawns, gardens, and publicly owned open areas.

Private, Domestic, and Stock - Water used from private wells or springs for individual homes, usually in rural areas not accessible to public water supply systems.

Wet and Open Water Areas - Includes lakes, reservoirs, rivers, wet areas used for aquatic wildlife refuge, and areas inundated or partially inundated adjacent to lakes, reservoirs, and rivers.

Culinary Supply - Water meeting all applicable safe drinking water requirements suitable for residential and commercial use.

Bird Refuge - Water diverted to the Bear River Migratory Bird Refuge and used to provide waterfowl habitat.

5.6 REFERENCES

In addition to the references listed below, the Utah State Water Plan, January 1990, discusses statewide aspects of water supply and use, including interbasin water supply planning.

1. "Summary Report, Water and Related Land Resources, Bear River Basin," Cooperative Study, U.S. Department of Agriculture in cooperation with the States of Utah, Idaho, and Wyoming, 1978.

2. "Results from Bear River Model," unpublished memorandum by David Cole, Utah Division of Water Resources, Dec. 20, 1989.

3. Bear River Compact as Amended. Public Law 96-189, 96th Congress. Feb. 8, 1980.

4. "Overview of the Proposed Lower Bear River Water Development Plan", Utah Division of Water Resources, December 1988.

5. "Wasatch Front Total Water Management Study," U.S. Bureau of Reclamation and Utah Division of Water Resources, February 1990.

6. U.S. Geological Survey Water Resources Data for Utah.

7. "Present Water Supplies, Uses and Rights - Bear River Development;" Hansen, Allen and Luce, Inc. For Utah Division of Water Resources, June 1991.